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ABSTRACT

Presented are the methodology and results of an equipercentile equating study in which subtests of the following three editions of multiple aptitude test batteries, in widespread use in 1960, were equated to the tests of the Project TALENT test battery: Flanagan Aptitude Classification Tests (1957); Differential Aptitude Tests (1947) and; the General Aptitude Test Battery (1952). Since Project TALENT tests were administered to large samples of students representative of the entire American secondary school population, the purpose of the study was to enable the three non-TALENT test batteries to be interpreted in terms of Project TALENT test norms. The study reports equivalent scores for groups of 257 boys and 286 girls who took each of the tests in question. The equating procedure is fully described in terms of: estimating reliabilities, using comparable true scores rather than raw scores; correction for growth on the three sets of non-TALENT test scores, since these were taken by students approximately six months after having been administered TALENT tests; and the seven point and five point smoothing formulas employed. Tables of the tests equated, statistical data, and one decimal raw-score equivalents on selected TALENT tests for integral raw-scores on the equatable non-TALENT subtests are provided. (AEF)

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Project TALENT

PROJECT TALENT TESTS AS ANCHORS FOR EQUATING OTHER TESTS

Edward E. Cureton

TM 810 562

AMERICAN INSTITUTES FOR RESEARCH
Palo Alto, California

1973

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Edward E. Cureton

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American Institutes for Research
Palo Alto, California

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PREFACE

This study reports, for a group of 257 boys and a group of 286 girls, the equivalent scores on selected Project TALENT tests of most of the subtests of the Flanagan Aptitude Classification Tests, all subtests of the Differential Aptitude Tests, and the first seven subtests of the General Aptitude Test Battery. For each of these batteries the tests equated were those of the edition in common use in 1960. These same data, along with scores on the subtests of the Essential High School Content Battery, were the basis of a set of factor analysis studies reported in Cureton (1968).

I am greatly indebted to the many people who helped make this study possible. Dr. Mildred E. Doyle, Superintendent of Schools of Knox County, Tennessee, approved the project and obtained the cooperation of the county high schools. Miss Oriana Howley, Director of Guidance, made the administrative arrangements. Special thanks are due to the principals, counselors, and teachers of the Knox County high schools: all of them responded wholeheartedly in rearranging schedules and administering several large batteries of tests.

The American Institutes for Research lent reusable booklets, donated hand-scorable booklets and answer sheets, and did all the scoring of the Flanagan Aptitude Classification Tests. For this I am indebted to Dr. John C. Flanagan.

Thanks are due to the Psychological Corporation, and especially to Dr. George K. Bennett and Dr. Alexander G. Wesman, for donating the test booklets and answer sheets for the Differential Aptitude Tests and for scoring all the answer sheets.

I am indebted particularly to Mr. Frank P. Early of the State Department of Employment Security and Mr. Fred W. Vance of its Knoxville office, for supplying all necessary materials for the General Aptitude Test Battery and for having all the examining and scoring done by their Knoxville staff.

Thanks are due to the computing centers of the University of Tennessee and the Oak Ridge National Laboratory, and especially to Mr. Richard C. Durfee, programmer.

I am especially indebted to Miss Marion Shaycoft, of the Project TALENT staff, who read the first draft of this report, offered a number of valuable suggestions for its improvement, prepared the special Project TALENT norms given in Table 36, and served as copy editor and format designer for the final manuscript.

Finally I am indebted to my wife, Dr. Louise W. Cureton, not only for encouragement and assistance throughout the study, but also in her capacity as Project TALENT Regional Coordinator for East Tennessee, for general supervision of all the testing and for liaison with the main office of Project TALENT as the study progressed.

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Chapter 1. THE TESTS AND THE SAMPLES

This report gives the methodology and results of an equipercentile equating study in which most of the tests of three widely used multiple aptitude batteries were equated to tests of the Project TALENT battery. The purpose of the equating was to enable the tests of the three other batteries to be interpreted in terms of the Project TALENT norms, which were based on very large samples representative of the entire population of American secondary school students.

The original test battery consisted of 91 tests: 43 from the Project TALENT battery and 48 from four other batteries. The Project TALENT tests were administered during March and April 1960 as a part of the national Project TALENT testing program. The other tests were administered at various times during the following fall, from late September to early December.

The Flanagan Aptitude Classification Tests included 17 of the 19 tests of the 1957 edition: all except Precision and Coordination.

For the Differential Aptitude Tests (third edition, 1947, Form A), all tests were used, and for the Language Usage test, the Spelling and Sentences parts were scored separately.

Though all subtests of the General Aptitude Test Battery, including the apparatus tests, were administered (separate-answer-sheet Form A, B1002A, 1952), only seven of the twelve scores were equated. There were no Project TALENT tests sufficiently similar to the Mark Making test and the apparatus tests to permit meaningful equating.

The subtests of the Essential High School Content Battery were not equated to the Project TALENT tests because this battery is now out of print.

The students of ten county schools participated in the study. About half of them were from the suburbs of a city of about 120,000 population; about half from rural areas. About 1600 took the Project TALENT tests as high school juniors in the spring, and about 1500 of these took one or more of the other batteries the following fall.

A large number of students missed one or more test sessions, and more cases were lost because the identifying data on their several answer sheets did not match. In consequence there remained at the finish only 543 cases for which data on all subtests were complete: 257 boys and 286 girls. The equating was done separately for boys and girls.

The first major problem was to decide which Project TALENT test to use as the basis for equating each of the 32 subtests of the other three batteries. Intercorrelations, cosines of angles between test vectors in the common-factor space, and stepwise regression analyses were prepared. The results of these analyses were highly inconsistent, due partly to the variations in the time intervals separating the administration of the tests, but probably more to the great differences in the numbers of items and the reliabilities of these tests. It was decided finally to equate each non-TALENT subtest to the TALENT subtest most nearly similar to it.* In most cases each non-TALENT test was equated to the one TALENT test it most closely resembled, but in a few cases it was equated to a composite of two or more TALENT tests.

Table 1 lists the tests and composites used in this study. The variable numbers are those of the factor analysis study. In that study only one composite was used: variable 1 was a composite of two Project TALENT vocabulary tests. In this study two additional composites were used: a special composite of two English tests, and the regular Project TALENT English Total, a composite of five.

The maximum score for each test is given at the right in Table 1. For the TALENT tests, these maxima range from 15 to 113; for the non-TALENT subtests, from 20 to 150. The total score ranges, however, may in certain cases exceed the maximum scores: negative scores may be obtained on some of the tests, including especially tests 40-43.

Table 2 lists the TALENT tests and composites used in this study, and the non-TALENT test or tests equated to each of them. In most cases the similarity is striking, but in a few it is only moderate.

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*I am indebted to Dr. John C. Flanagan and to Marion F. Shaycoft of Project TALENT for advice concerning these similarities.

TABLE 1. The Tests

Var. No.	Code or Subtest	Title of Test Project TALENT	Max. Score
1	R-172	Vocabulary (R-102 + R-162)	30
23	R-212	Memory for Words (Study 24 "Vlaznoor"-English pairs. Recognize English equivalent later.)	24
25	R-231	Spelling (Identify misspelled word if any from list of 4, plus "None of the above.")	16
25-29	R-230	English Total: Spelling, Capitalization, Punctuation, Usage, Effective Expression (R-231 + R-232 + R-233 + R-234 + R-235)	113
28+29	R-236	Usage + Effective Expression (R-234 + R-235)	37
31	R-250	Reading Comprehension (Paragraph and questions)	48
32	R-260	Creativity (Practical problem stated. Examinee selects clever solution: answers give only first and last letters.)	20
33	R-270	Mechanical Reasoning (Like Bennett)	20
34	R-281	Visualization in 2 Dimensions (Rotate key figure to match answer without turning over.)	24
35	R-282	Visualization in 3 Dimensions (Pattern and 5 fold-ups. Pick correct fold-up.)	16
36	R-290	Abstract Reasoning (2-way figure matrix. Select choice for missing element.)	15
37	R-311	Arithmetic Reasoning (Verbal problem and 4 or 5 options)	16
40	F-410	Arithmetic Computation (Add, subtract, multiply, and divide whole numbers.)	72
41	F-420	Table Reading (Two-argument table: dollar entries)	72
42	F-430	Clerical Checking (Like Minnesota name checking)	74
43	F-440	Object Inspection (Identical forms: one different)	40

(continued on next page)

TABLE 1. (continued)

Var. No.	Code or Subtest	Title of Test Flanagan Aptitude Classification Tests	Max. Score
44	1	Inspection (Identical forms: one different)	80
45	2	Mechanics (Pictures, each with several questions)	30
46	3	Tables (Two-argument tables: RPM and Name entries)	120
47	4	Reasoning (Verbal Problem to formula or answer)	24
48	5	Vocabulary	60
49	6	Assembly (3-dimensional paper form board: mechanical assemblies)	20
50	7	Judgment and Comprehension (Paragraphs with extrapolation and inference questions)	24
51	8	Components (Like Gottschaldt: hidden figures, mostly 3-dimensional)	40
52	9	Planning (Organizational rearrangement: main-step and substep position scored)	32
53	10	Arithmetic (Add, subtract, mixed add and subtract, count X's, multiply, divide, mixed multiply and divide)	120
54	11	Ingenuity (Like 32: TALENT Creativity)	24
55	12	Scales (Graph reading)	72
56	13	Expression (Grammatical sentences TF--40 items; best and worst sentence out of 3--12 triads.)	64
57	15	Alertness (Find dangerous item in picture.)	36
58	17	Patterns (Copying on graph paper: 18 direct and 12 upside down)	60
59	18	Coding (6 categories and 5 subcategories each. Memorize codes: practice exercises. 3 and 6 choice)	120
60	19	Memory (Code memory: 30-choice)	30

TABLE 1. (continued)

Var. No.	Code or Subtest	Title of Test	Max. Score
		Differential Aptitude Tests	
61	1	Verbal Reasoning (Verbal analogies: 2-blank)	50
62	2	Numerical Ability (Arithmetic computation: easy to hard)	40
63	3	Abstract Reasoning (Figure classification)	50
64	4	Space Relations (Pattern and fold-ups, multiple answers)	100
65	5	Mechanical Reasoning (Like Bennett)	68
66	6	Clerical Speed and Accuracy (Match pairs of letters and numbers from booklet to answer sheet.)	100
67	7I	Spelling (single words: TF)	100
68	7II	Sentences (each divided into 5 parts. Mark all parts which contain errors in grammar, punctuation, or spelling. 50 items, 250 parts, 95 actual errors. R-W)	95
		General Aptitude Test Battery	
69	1	Name Comparison (Like Minnesota)	150
70	2	Computation (Arithmetic computation, easy to hard)	50
71	3	Three-dimensional Space (Pattern and fold-ups)	40
72	4	Vocabulary (same-opposite)	60
73	5	Tool Matching (Identical forms: much more speed than in TALENT and FACT inspection)	49
74	6	Arithmetic Reasoning (Verbal problems)	25
75	7	Form Matching (Two half-pages of same forms in random arrangements)	60

TABLE 2. Tests Equated

TALENT test or composite			Non-TALENT test or tests equated to this TALENT test or composite		
Variable No.	Code	Test Name	Variable No.	Code	Test Name
1	R-172	Vocabulary	48	FACT-5	Vocabulary
			61	DAT-1	Verbal Reasoning
			72	GATB-4	Vocabulary
23	R-212	Memory for Words	60	FACT-19	Memory
25	R-231	Spelling	67	DAT-7I	Spelling
25-29	R-230	English Total	68	DAT-7II	Sentences
28+29	R-236	Usage + Effective Expression	56	FACT-13	Expression
31	R-250	Reading Comprehension	50	FACT-7	Judgment and Comprehension
			52	FACT-9	Planning
32	R-260	Creativity	54	FACT-11	Ingenuity
33	R-270	Mechanical Reasoning	45	FACT-2	Mechanics
			65	DAT-5	Mechanical Reasoning
34	R-281	Visualization in 2 Dimensions	51	FACT-8	Components
35	R-282	Visualization in 3 Dimensions	49	FACT-6	Assembly
			58	FACT-17	Patterns
			64	DAT-4	Space Relations
			71	GATB-3	Three-dimensional Space
36	R-290	Abstract Reasoning	55	FACT-12	Scales
			63	DAT-3	Abstract Reasoning
37	R-311	Arithmetic Reasoning	47	FACT-4	Reasoning
			74	GATB-6	Arithmetic Reasoning
40	F-410	Arithmetic Computation	53	FACT-10	Arithmetic
			62	DAT-2	Numerical Ability
			70	GATB-2	Computation
41	F-420	Table Reading	46	FACT-3	Tables
			59	FACT-18	Coding
42	F-430	Clerical Checking	66	DAT-6	Clerical Speed & Accuracy
			69	GATB-1	Name Comparison
43	F-440	Object Inspection	44	FACT-1	Inspection
			57	FACT-15	Alertness
			73	GATB-5	Tool Matching
			75	GATB-7	Form Matching

Chapter 2. PROCEDURES

In equating tests whose reliabilities are in most cases far from equal, the comparable scores are true scores rather than raw scores (Flanagan, 1951). In order to apply the necessary corrections, we need to know the reliabilities of all the tests. In the present study, reliability coefficients were not computed, so it was necessary to estimate the reliabilities in our samples from those given in previous Project TALENT reports and in the authors' manuals for the non-TALENT tests.

ESTIMATION OF RELIABILITIES

Shaycoft (1967, Tables 4-6, pp. 4-16 and 4-17) gives reliability data for those TALENT tests which are essentially power tests rather than speed tests. The coefficients are split-half correlations raised by the Angoff (1953) formula 16, which reduces to the Spearman-Brown formula when the half-test variances are equal. The reliabilities and standard deviations used were those for Shaycoft's grade 12 "matched retest cases," these being the groups (male and female) for which her reliability coefficients were computed directly. The samples were somewhat different for different tests, but all of them were large (518 to 3,676). With these reliability coefficients, the accompanying standard deviations, and the standard deviations of our own samples (shown in Table 4), the reliability coefficients for our samples were estimated, for the variables with variable numbers below 40, by the formula for the correction for range of ability.

Shaycoft reported the reliability and standard deviation for the composite of variables 25-29 (the English total). For our samples, the standard deviations of the composite were computed by the usual formula for the standard deviation of a sum, using our data for the standard deviations and intercorrelations of the five individual tests.

For the composite of variables 28 and 29, the same procedure was used, except that the reliabilities for the Shaycoft samples were computed from the individual reliabilities and standard deviations by the formula for the

TABLE 3. Estimates of Reliability

Var.	Test	Method* M	Method* F	Reliability M	Reliability F	Growth Increment
1	R-172	cr	cr	.840	.807	.413
23	R-212	cr	cr	.851	.885	.105
25	R-231	cr	cr	.643	.590	.219
25-29	R-230	cr	cr	.887	.862	.917
28+29	R-234+R-235	cr	cr	.709	.638	.176
31	R-250	cr	cr	.916	.898	.715
32	R-260	cr	cr	.789	.654	.233
33	R-270	cr	cr	.799	.664	.110
34	R-281	cr	cr	.811	.777	.043
35	R-282	cr	cr	.746	.618	.116
36	R-290	cr	cr	.707	.683	.133
37	R-311	cr	cr	.755	.710	.221
40	F-410	rmax	rmax	.624	.656	1.062
41	F-420	rmax	rmax	.494	.419	.447
42	F-430	rmax	rmax	.494	.364	.894
43	F-440	rmax	rmax	.361	.419	.129
44	FACT-1	cr	cr	.634	.634	
45	FACT-2	cr	rmax	.645	.307	
46	FACT-3	cr	cr	.561	.578	
47	FACT-4	cr	cr	.763	.710	
48	FACT-5	cr	cr	.897	.887	
49	FACT-6	cr	cr	.769	.698	
50	FACT-7	cr	cr	.761	.712	
51	FACT-8	cr	cr	.823	.781	
52	FACT-9	cr	cr	.665	.546	
53	FACT-10	cr	cr	.732	.711	
54	FACT-11	cr	cr	.782	.758	
55	FACT-12	cr	cr	.608	.549	
56	FACT-13	cr	cr	.824	.817	
57	FACT-15	rmax	cr	.458	.394	
58	FACT-17	cr	cr	.793	.732	
59	FACT-18	crest	crest	.758	.696	
60	FACT-19	crest	crest	.567	.539	

TABLE 3. (continued)

Var.	Test	Method* M	Method* F	Reliability M	Reliability F
61	DAT-1	cr	cr	.937	.943
62	DAT-2	cr	cr	.920	.910
63	DAT-3	cr	cr	.912	.887
64	DAT-4	cr	cr	.919	.885
65	DAT-5	cr	cr	.827	.719
66	DAT-6	cr	cr	.925	.838
67	DAT-7I	cr	cr	.932	.923
68	DAT-7II	cr	cr	.919	.927
69	GATB-1	rmax	rmax	.569	.586
70	GATB-2	rcor	rcor	.761	.895
71	GATB-3	rmax	rmax	.574	.528
72	GATB-4	rmax	rcor	.803	.813
73	GATB-5	rmax	rmax	.569	.586
74	GATB-6	rcor	rcor	.733	.739
75	GATB-7	rmax	rmax	.456	.456

*cr: estimated by correction for range, based on data given in published manual or report.

crest: estimated by correction for range, based on estimate of reliability from data given in manual (see text).

rcor: estimated from formula for correction for attenuation, assuming that the corrected correlation with a similar test is .95.

rmax: assumed equal to highest correlation between given test and any other test in the battery.

reliability of the sum of two tests. The intercorrelations were taken from her tables 6-1a (p. 6-6) and 6-1b (p. 6-14): the correlations between her variables 34 and 35, for boys and girls.

These procedures gave estimates of reliability for our samples, all of which appeared to be good.

For the Flanagan Aptitude Classification Tests, the Technical Report (Flanagan, 1959, Table 4-1, p. 16) gives split-half, Spearman-Brown reliabilities for all tests except the last two (variables 59 and 60), based on the scores of 1056 twelfth-grade students of both sexes tested in 1958. The corresponding standard deviations are given in Table 5-2 (p. 19) of that report. For variables 44-58, estimates of reliability for our groups were computed by the correction-for-range formula.

For variables 59 and 60, the Technical Report gives only alternate-form reliabilities based on a twelfth-grade sample of 240 tested in 1952. This latter study includes alternate-form reliabilities for some of the other tests, and split-half reliabilities for some. Using ratios of reliabilities of the same tests from the two studies, rough corrections were derived for the average difference in reliability in the two groups, and for the average difference between split-half and alternate-form reliabilities. These corrections were then applied to the alternate-forms reliabilities of variables 59 and 60 to give estimates equivalent to the split-half reliabilities of the other tests and compatible with the 1958 standard deviations. This procedure raised the estimated reliability from .75 to .79 for variable 59, and from .55 to .62 for variable 60. These two larger figures were used in the formula for the correction for range.

For the Differential Aptitude Tests, Form A, variables 61-68, reliabilities and standard deviations are given in the Manual for the Third Edition (1959), Table 26, page 66. The values used were those for Grade 12. For all variables except 66 (Clerical Speed and Accuracy) they are split-half, Spearman-Brown reliabilities. For variable 66 they are Form A-Form B correlations, the two forms having been administered consecutively in one test session. These correlations were used in the correction-for-range formula.

For the TALENT tests of variables 40-43, and for the tests of the General Aptitude Test Battery, variables 69-75, no reliabilities of the

internal-consistency type were available. In this situation rather crude methods of estimation were necessary. For each of these tests there was at least one other test which it resembled fairly closely in content and format, and for which a reliability estimate based on the correction for range was available, along with the correlation between the given test and the similar test. Using these data, the formula for the correlation corrected for attenuation was solved for the reliability of the given test, under the assumption that the corrected correlation would be .95. If the given test resembled closely more than one other test for which an apparently good reliability estimate was available, its reliability was estimated from each of them by this procedure, and the highest estimate was accepted provisionally.

This procedure gave apparently good estimates in some cases, but in others it gave estimates which seemed to be too low. In these cases the assumed corrected correlation of .95 was probably too high, but there was no way of knowing how much too high. As an alternative estimate, we could assume the reliability of the given test to be equal to its highest correlation with any other test in the battery (including those TALENT tests to which no non-TALENT tests were to be equated). Wherever the highest correlation exceeded the estimate based on the assumption that the corrected correlation would be .95, this highest correlation was taken as the estimate of reliability.

The estimate based on the assumption of corrected correlation .95 is more likely to be an underestimate than an overestimate: corrected correlations are often lower than .95 even when tests are apparently quite similar. The highest correlation between the given test and any other may be either an underestimate or an overestimate. It can be an overestimate if the other test is much more reliable than the given test and is very similar. This situation is not too common, however. In any event, the best estimate available for variables 40-43 and 69-75 seemed to be either the highest estimate based on an assumed corrected correlation of .95, or the highest correlation with any other test, whichever was highest. It should be noted that in the present context, the highest estimate of a reliability is the most conservative. If we simply equated raw scores, we would in effect be assuming that the reliabilities of both of the tests equated were equal,

TABLE 4. Means, Standard Deviations, Grouping Intervals, and Smoothing Ranges

Var.	Test	Mean		Standard Deviations		Grouping Intervals		Smoothing Ranges	
		M	F	M	F	M	F	M	F
1	R-172	19.81	18.54	5.31	5.29	1	1	7	7
23	R-212	11.86	13.97	5.33	5.79	1	1	7	7
25	R-231	9.51	10.85	2.76	2.50	1	1	5	5
25-29	R-230	84.00	89.77	11.71	9.87	2	2	7	7
28+29	R-234+R-235	25.94	27.43	4.60	3.91	1	1	7	7
31	R-250	33.30	34.10	10.33	8.70	2	2	7	7
32	R-260	10.12	9.19	4.12	3.26	1	1	7	5
33	R-270	13.42	9.13	3.52	3.21	1	1	7	5
34	R-281	14.54	12.52	5.60	5.15	1	1	7	7
35	R-282	9.86	8.74	3.08	2.66	1	1	5	5
36	R-290	9.38	9.30	2.79	2.71	1	1	5	5
37	R-311	9.35	8.53	3.48	3.28	1	1	5	5
40	F-410	28.86	32.08	18.15	16.86	4	4	7	7
41	F-420	11.38	11.65	8.25	4.70	2	1	7	7
42	F-430	25.56	30.56	18.15	16.40	4	4	7	7
43	F-440	21.71	22.63	7.57	6.30	2	2	7	5
44	FACT-1	50.04	51.85	9.42	9.18	2	2	7	7
45	FACT-2	13.92	9.46	4.80	2.68	1	1	7	7
46	FACT-3	49.62	53.74	11.79	12.02	3	3	7	7
47	FACT-4	10.80	9.20	5.10	4.61	1	1	7	7
48	FACT-5	21.12	21.76	11.04	10.55	3	2	7	7
49	FACT-6	11.61	10.58	4.07	3.56	1	1	7	7
50	FACT-7	15.46	14.55	4.02	3.66	1	1	7	7
51	FACT-8	23.19	21.57	7.79	7.01	2	2	7	7
52	FACT-9	22.68	23.85	5.30	4.55	1	1	7	7
53	FACT-10	48.50	48.26	10.67	10.26	2	2	7	7
54	FACT-11	15.04	14.15	4.52	4.29	1	1	7	7
55	FACT-12	26.57	23.46	8.42	7.85	2	1	7	7
56	FACT-13	42.84	46.67	7.80	7.65	2	2	7	7
57	FACT-15	26.84	24.11	4.68	4.51	1	1	7	7
58	FACT-17	17.76	14.26	10.79	9.47	2	2	7	7
59	FACT-18	106.24	110.28	16.60	14.81	4	4	7	7
60	FACT-19	18.80	19.34	7.55	7.32	2	2	7	7

TABLE 4. (continued)

Var.	Test	Mean		Standard Deviations		Grouping Intervals		Smoothing Ranges	
		M	F	M	F	M	F	M	F
61	DAT-1	26.78	26.76	10.08	10.01	2	2	7	7
62	DAT-2	23.81	19.75	10.16	10.28	2	2	7	7
63	DAT-3	30.12	29.54	10.22	10.37	2	2	7	7
64	DAT-4	52.87	48.53	22.39	19.46	5	5	7	7
65	DAT-5	44.25	28.84	11.44	10.23	3	2	7	7
66	DAT-6	58.39	64.40	11.80	9.90	3	2	7	7
67	DAT-7I	55.50	67.94	25.45	21.36	6	5	7	7
68	DAT-7II	39.13	46.85	17.59	16.46	4	4	7	7
69	GATB-1	53.84	61.83	10.36	11.70	2	3	7	7
70	GATB-2	26.51	26.60	4.73	4.94	1	1	7	7
71	GATB-3	20.07	18.47	5.27	4.64	1	1	7	7
72	GATB-4	21.79	23.00	7.49	7.55	2	2	7	7
73	GATB-5	33.99	35.95	5.05	4.88	1	1	7	7
74	GATB-6	13.16	12.23	3.19	3.28	1	1	5	5
75	GATB-7	30.04	30.46	5.69	5.66	1	1	7	7

and if we use high estimates uniformly, the ratios of pairs of such estimated reliabilities will be minimal.

In the case of variable 57 (boys, FACT-15, Alertness), the reliability .438 calculated from the FACT Technical Report data was raised to .458 because this test correlated .458 with variable 44, FACT-1, Inspection.

Table 3 shows the estimated reliabilities of the tests, and the method by which each of them was computed.

There is still at least one anomalous figure in Table 3. The value .307 for the reliability of variable 45 (FACT-2: Mechanics) for the girls seems to be too low. The reason is that in our sample the corresponding standard deviation is very low: 2.68 as compared with 4.80 for the boys. All of the estimates for variables 41, 42, and 43 may well be low also, but there seems to be no better method of estimation available for these tests.

CORRECTION FOR GROWTH

The non-TALENT tests were given on the average about six months later than the TALENT tests. In The American High School Student (Flanagan et al, 1964), Table 3-1 (pp. 3-4 to 3-7) means are given by grades; and Table 3-2, immediately following, gives selected percentiles. The differences between the scores at the same percentiles for the 11th and 12th grades are in general small, and are smaller at the extremes than in the middle. Since these differences are much smaller than the errors of measurement, and since the variations by sex are even smaller, we simply took one-third of the difference between the 11th and 12th grade means, for boys and girls combined, as the correction for growth (one-third instead of one-half because, as noted, the differences are smaller at the extremes). The growth increments for the TALENT tests are given in the last column of Table 3. Note that for only one test was the increment as much as one raw-score point.

EQUATING PROCEDURE

Grouped frequency distributions were first prepared for each test by sex. The grouping interval for each test, if greater than one, was chosen so as to make the standard deviation of the grouped frequencies at least 3.5, but as little greater than this as possible.

Each frequency distribution was then smoothed by using a seven-point weighted moving average, which preserves parabolic and cubic trends over each

successive seven points, leaving three degrees of freedom for smoothing. For those ungrouped variables (and one variable grouped by 2's) whose standard deviations were less than 3.5, a five-point formula was used, leaving only one degree of freedom for smoothing. The value 3.5 was chosen because a seven-point range includes six grouping intervals, and a parabolic or cubic fitted near the mode of the distribution will not preserve the main trends if it covers or comes too close to both points of inflection, which latter tend generally to lie near plus and minus one standard deviation.

If two tests are unequally reliable, the scores which are regarded as equivalent are the true scores lying at the same percentiles. The standard deviation of the true scores is the standard deviation of the raw scores times the square root of the reliability coefficient. For each test, the midpoint X_i of each grouping interval was therefore moved in toward the mean: $X_i - \bar{X}$ was replaced by $(X_i-\bar{X})\sqrt{r_{11}}$, so that X_i became $\bar{X}+(X_i-\bar{X})\sqrt{r_{11}}$. In the case of the TALENT tests the growth increment k was added to this latter value. The means are given in Table 4.

Using the adjusted midpoints and the smoothed frequencies, 25 selected percentiles were then computed for each frequency distribution. The selected percentiles were .1, .2, .5, 1, 2, 3, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 85, 90, 95, 97, 98, 99, 99.5, 99.8, and 99.9.

For each pair of tests to be equated, the adjusted scores at the selected percentiles were assumed to be equivalent. Smoothing by weighted moving averages, however, still leaves some irregularities, and a procedure equivalent to plotting the paired scores at the selected percentiles and drawing a smooth curve as close as possible to them is required. We regarded the non-TALENT score of each pair as fixed, and fitted a power series in such a manner as to minimize the sum of squares of deviations of the TALENT scores at the selected percentiles. The program used the method of orthogonal polynomials, selected the best-fitting series from a parabola to a quintic, computed and printed the table of equivalents, plotted the equipercentile points on a graph, and drew the curve. In a few cases the best-fitting series was not monotonic: the curve turned up at the bottom and/or down at the top. Most of these cases were resolved with relatively slight loss in goodness of fit by using a series one or two lower in degree than the best-fitting series. In two cases, the extremes of the curve were adjusted by eye

to attain monotonicity, and in one case a seventh degree curve gave a better fit.

In one case, FACT Coding against TALENT Table Reading, equating was impossible. For the former the frequencies piled up heavily near the perfect score, and for the latter they piled up heavily near the zero score. This situation obtained for both boys and girls. The equating curves had low slope up to about the medians, then turned upward fairly abruptly and became almost vertical.

The degrees of the curves used were as follows:

Degree	Boys	Girls
2	0	2
3	2	3
4	7	6
5	21	18
5 adj.*	1	1
7	0	1

*Curve rose slightly at bottom and was adjusted by eye to achieve monotonicity.

Figure 1 shows a fairly typical plot as it came from the computer. The variable numbers are those of Table 1: V47 is FACT-4: Reasoning, and V37 is TALENT R311: Arithmetic Reasoning; and the curve is a quintic.

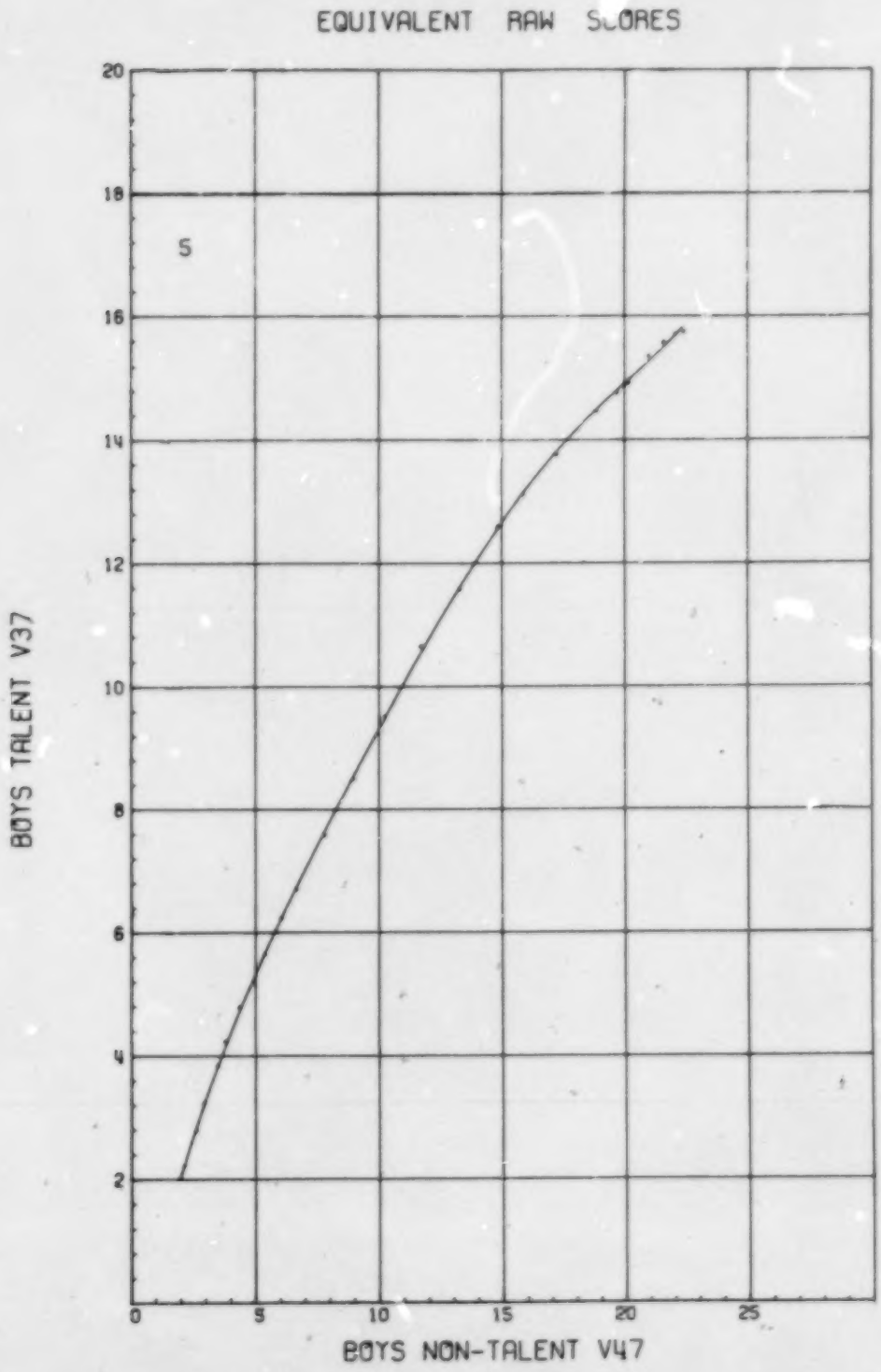
From these power-series fits, tables of TALENT scores, to one decimal, equivalent to integral non-TALENT scores, were prepared. Each table runs from the non-TALENT score next below the .1 percentile to the score next above the 99.9 percentile of the true-score distribution. For tests of low to moderate reliability, raw scores at the extremes cannot be equated with any useful precision, and even those beyond the first and 99th percentiles of the true-score distribution may have not-too-stable equivalents.

Table 4 shows for each test the mean and standard deviation of the raw scores, the grouping interval used, and the smoothing formula (7-point or 5-point) employed. Since these formulas are not in the standard references commonly used by educational and psychological statisticians, they are presented herewith.

Seven-point formula

$$\hat{f}_0 = (-2f_{-3} + 3f_{-2} + 6f_{-1} + 7f_0 + 6f_1 + 3f_2 - 2f_3)/21$$

FIGURE 1. Computer fitted curve, showing relation between:
Variable 47 (FACT-4: Reasoning)
and
Variable 37 (TALENT R-311: Arithmetic Reasoning)



Five-point formula

$$\hat{f}_0 = (-3f_{-2} + 12f_{-1} + 17f_0 + 12f_1 - 3f_2)/35$$

In these formulas, $\hat{f}_0$ is the smoothed frequency corresponding to the raw frequency f_0. The f's with negative subscripts are those immediately below f_0, and the f's with positive subscripts are those immediately above f_0. The denominators are the algebraic sums of the coefficients. At the extremes of the actual distribution we add three or four zero frequencies below the lowest non-zero frequency and above the highest. Occasionally there will be one smoothed non-zero frequency one step below the lowest actual frequency or above the highest. This happens most frequently when there is a substantial frequency at the highest or lowest possible actual score. In such cases, the smoothed frequency at the score one beyond the highest or lowest real score must be combined with the smoothed frequency <u>at</u> the latter.

In application, the values of N, the mean, the standard deviation, the skewness, and the kurtosis are preserved to a fairly high approximation by these formulas. By contrast, unweighted moving averages inflate the standard deviation and make the smoothed distribution more platykurtic than the original distribution. The derivation of these smoothing formulas is given in Appendix I.

Chapter 3. RESULTS

Tables 5 to 35 give one-decimal raw-score equivalents on selected TALENT tests for integral raw scores on the equatable non-TALENT subtests.

Norms for all but one of the TALENT tests are given in The American High School Student (Flanagan et al, 1964), Table 3-2, pp. 3-8 through 3-80. For the composite of variables 28 + 29, R234 + R235, Usage plus Effective Expression, special norms are given in Table 36.

TABLE 5. True Score Equating of FACT Inspection (Variable 44) to TALENT Object Inspection (Variable 43, F-440)

FACT-1 Inspection	F-440 - TALENT Object Inspection		FACT-1 Inspection	F-440 - TALENT Object Inspection	
	Boys	Girls		Boys	Girls
75	34.0		48	20.6	20.5
74	34.0		47	20.0	20.1
73	33.9	36.6	46	19.4	19.6
72	33.7	36.1	45	18.8	19.1
71	33.5	35.5	44	18.2	18.7
70	33.2	34.9	43	17.6	18.2
69	32.8	34.2	42	17.0	17.7
68	32.4	33.5	41	16.3	17.2
67	32.0	32.7	40	15.7	16.7
66	31.5	31.9	39	15.1	16.2
65	31.0	31.2	38	14.4	15.6
64	30.5	30.4	37	13.8	15.1
63	29.9	29.6	36	13.1	14.5
62	29.3	28.9	35	12.4	13.9
61	28.7	28.1	34	11.6	13.3
60	28.1	27.4	33	10.8	12.7
59	27.5	26.7	32	10.0	12.1
58	26.9	26.1	31	9.2	11.4
57	26.2	25.4	30	8.2	10.8
56	25.6	24.8	29	7.3	10.1
55	25.0	24.2	28	6.2	9.4
54	24.3	23.6	27	5.1	8.8
53	23.7	23.1	26		8.1
52	23.1	22.5	25		7.5
51	22.4	22.0	24		6.9
50	21.8	21.5	23		6.4
49	21.2	21.0	22		5.9

TABLE 6. True Score Equating of FACT Mechanics (Variable 45) to TALENT Mechanical Reasoning (Variable 33, R-270)

FACT-2 Mechanics	R-270 - TALENT Mechanical Reasoning	
	Boys	Girls
26	21.2	
25	20.2	
24	19.5	
23	19.0	
22	18.6	
21	18.3	
20	17.9	
19	17.6	
18	17.1	
17	16.6	
16	16.0	
15	15.2	16.8
14	14.3	15.5
13	13.3	15.0
12	12.2	14.0
11	11.0	12.4
10	9.8	10.3
9	8.6	8.2
8	7.4	6.5
7	6.4	5.2
6	5.5	3.7
5	4.9	0.6
4	4.6	

TABLE 7. True Score Equating of FACT Tables (Variable 46) to TALENT Table Reading (Variable 41, F-420)

FACT-3 Tables	F-420 - TALENT Table Reading		FACT-3 Tables	F-420 - TALENT Table Reading	
	Boys	Girls		Boys	Girls
86		24.9	49	9.8	10.5
85		24.5	48	9.4	10.1
84		24.1	47	9.1	9.8
83	58.9	23.6	46	8.9	9.4
82	56.5	23.2	45	8.6	9.1
81	54.1	22.8	44	8.4	8.7
80	51.8	22.4	43	8.2	8.4
79	49.5	22.0	42	7.9	8.1
78	47.2	21.5	41	7.7	7.7
77	45.0	21.1	40	7.4	7.4
76	42.8	20.7	39	7.1	7.1
75	40.7	20.3	38	6.8	6.7
74	38.6	19.9	37	6.5	6.4
73	36.6	19.5	36	6.1	6.1
72	34.6	19.1	35	5.6	5.8
71	32.8	18.7	34	5.0	5.4
70	30.9	18.3	33	4.4	5.1
69	29.2	17.9	32	3.7	4.8
68	27.5	17.5	31	2.8	4.5
67	25.9	17.1	30	1.9	4.2
66	24.4	16.7	29	0.8	3.9
65	23.0	16.4	28	-0.4	3.6
64	21.6	16.0	27	-1.8	3.3
63	20.3	15.6	26	-3.4	3.0
62	19.1	15.2	25	-5.1	2.7
61	18.0	14.8	24		2.4
60	16.9	14.5	23		2.1
59	15.9	14.1	22		1.8
58	15.0	13.7	21		1.5
57	14.2	13.3	20		1.2
56	13.4	13.0	19		0.9
55	12.7	12.6	18		0.6
54	12.1	12.2	17		0.3
53	11.5	11.9	16		0.0
52	11.0	11.5	15		-0.2
51	10.6	11.2	14		-0.5
50	10.1	10.8			

TABLE 8. True Score Equating of FACT Reasoning (Variable 47) to TALENT Arithmetic Reasoning (Variable 37, R-311)

FACT-4 Reasoning	R-311 - TALENT Arithmetic Reasoning	
	Boys	Girls
23	16.1	
22	15.6	15.3
21	15.3	15.2
20	14.9	15.0
19	14.5	14.7
18	14.1	14.3
17	13.7	13.8
16	13.2	13.3
15	12.7	12.8
14	12.1	12.2
13	11.4	11.7
12	10.7	11.0
11	10.0	10.4
10	9.3	9.7
9	8.6	8.9
8	7.8	8.1
7	7.0	7.3
6	6.2	6.4
5	5.3	5.5
4	4.4	4.7
3	3.3	3.8
2	2.1	3.0
1	0.6	2.4

TABLE 9. True Score Equating of FACT Vocabulary (Variable 48) to TALENT Vocabulary (Variable 1, R-172)

FACT-5 Vocabulary	R-172 - TALENT Vocabulary		FACT-5 Vocabulary	R-172 - TALENT Vocabulary	
	Boys	Girls		Boys	Girls
56	29.7	30.0	28	24.8	23.0
55	29.7	29.5	27	24.6	22.6
54	29.6	29.1	26	24.2	22.1
53	29.5	28.8	25	23.9	21.7
52	29.3	28.5	24	23.5	21.2
51	29.1	28.2	23	23.1	20.7
50	28.9	27.9	22	22.6	20.1
49	28.6	27.7	21	22.1	19.6
48	28.4	27.5	20	21.5	19.0
47	28.2	27.3	19	20.9	18.4
46	28.0	27.1	18	20.2	17.7
45	27.8	26.9	17	19.5	17.1
44	27.6	26.8	16	18.8	16.4
43	27.4	26.6	15	18.0	15.7
42	27.2	26.4	14	17.2	15.0
41	27.0	26.3	13	16.3	14.2
40	26.9	26.1	12	15.4	13.5
39	26.7	25.9	11	14.5	12.7
38	26.6	25.8	10	13.6	11.9
37	26.4	25.6	9	12.7	11.1
36	26.3	25.4	8	11.8	10.3
35	26.2	25.1	7	11.0	9.5
34	26.0	24.9	6	10.1	8.7
33	25.9	24.6	5	9.3	7.9
32	25.7	24.3	4	8.6	7.1
31	25.5	24.0	3	8.0	6.3
30	25.3	23.7	2	7.5	
29	25.1	23.3			

TABLE 10. True Score Equating of FACT Assembly (Variable 49) to TALENT Visualization in 3 Dimensions (Variable 35, R-282)

FACT-6 Assembly	R-282 - TALENT Visualization in 3 Dimensions	
	Boys	Girls
20	16.6	
19	16.3	14.0
18	15.5	14.0
17	14.6	13.7
16	13.5	13.1
15	12.5	12.4
14	11.5	11.5
13	10.7	10.6
12	9.9	9.8
11	9.3	8.9
10	8.7	8.2
9	8.1	7.5
8	7.5	6.9
7	6.8	6.3
6	6.1	5.8
5	5.4	5.3
4	4.6	4.7
3	3.8	4.0
2	3.2	3.1

TABLE 11. True Score Equating of FACT Judgment & Comprehension (Variable 50) to TALENT Reading Comprehension (Variable 31, R-250)

FACT-7 Judgment & Comprehension	R-250 - TALENT Reading Comprehension	
	Boys	Girls
24	48.9	
23	49.4	48.7
22	48.9	48.6
21	47.6	48.0
20	45.9	47.0
19	43.8	45.6
18	41.5	43.9
17	39.1	41.8
16	36.5	39.6
15	33.7	37.0
14	30.7	34.3
13	27.6	31.4
12	24.3	28.3
11	20.8	25.2
10	17.3	22.0
9	13.8	18.7
8	10.6	15.5
7	8.2	12.3
6	7.3	9.2
5	6.3	6.1
4	5.6	

TABLE 12. True Score Equating of FACT Components (Variable 51) tc TALENT Visualization in 2 Dimensions (Variable 34, R-281)

FACT-8 Components	R-281 - TALENT Visualization in 2 Dimensions	
	Boys	Girls
41	24.2	
40	24.2	23.0
39	23.9	22.8
38	23.5	22.4
37	23.1	21.9
36	22.5	21.4
35	22.0	20.9
34	21.4	20.3
33	20.8	19.8
32	20.2	19.2
31	19.6	18.7
30	19.1	18.2
29	18.6	17.6
28	18.1	17.1
27	17.5	16.6
26	17.0	16.0
25	16.5	15.5
24	15.9	14.9
23	15.4	14.3
22	14.7	13.6
21	14.0	12.9
20	13.3	12.1
19	12.5	11.3
18	11.6	10.4
17	10.6	9.5
16	9.6	8.5
15	8.6	7.5
14	7.5	6.4
13	6.4	5.3
12	5.2	4.3
11	4.2	3.2
10	3.2	2.3
9	2.3	1.4
8	1.7	0.7
7	1.3	0.3
6	1.2	

TABLE 13. True Score Equating of FACT Planning (Variable 52) to TALENT Reading Comprehension (Variable 31, R-250)

FACT-9 Planning	R-250 - TALENT Reading Comprehension	
	Boys	Girls
31	49.7	48.3
30	49.3	48.1
29	48.3	47.2
28	46.9	45.5
27	45.0	43.4
26	42.7	40.8
25	40.2	38.0
24	37.6	35.0
23	34.8	32.0
22	31.9	29.2
21	29.1	26.5
20	26.3	24.2
19	23.7	22.2
18	21.2	20.5
17	18.9	19.2
16	16.8	18.1
15	15.0	17.1
14	13.4	16.0
13	12.0	14.6
12	10.9	12.5
11	10.0	9.2
10	9.3	4.4
9	8.8	
8	8.3	
7	7.9	
6	7.4	
5	6.8	
4	5.9	

TABLE 14. True Score Equating of FACT Arithmetic (Variable 53) to TALENT Arithmetic Computation (Variable 40, F-410)

FACT-10 Arithmetic	F-410 - TALENT Arithmetic Computation		FACT-10 Arithmetic	F-410 - TALENT Arithmetic Computation	
	Boys	Girls		Boys	Girls
80	56.1		51	34.8	37.6
79	54.5	62.7	50	33.7	36.5
78	53.2	60.9	49	32.7	35.5
77	52.3	.5	48	31.7	34.5
76	51.7	58.3	47	30.6	33.5
75	51.2	57.4	46	29.6	32.5
74	50.9	56.6	45	28.6	31.5
73	50.7	56.0	44	27.5	30.5
72	50.5	55.4	43	26.3	29.4
71	50.3	54.9	42	25.0	28.2
70	50.1	54.4	41	23.6	26.9
69	49.9	53.9	40	22.0	25.5
68	49.6	53.4	39	20.2	23.9
67	49.2	52.8	38	18.1	22.0
66	48.8	52.2	37	15.6	19.8
65	48.3	51.5	36	12.6	17.2
64	47.7	50.8	35	9.2	14.2
63	47.0	50.0	34	5.1	10.6
62	46.2	49.1	33	0.3	6.5
61	45.3	48.2	32	-5.4	1.6
60	44.4	47.2	31	-12.0	-4.1
59	43.4	46.2	30	-19.7	-10.8
58	42.4	45.2	29	-28.7	-18.5
57	41.4	44.1	28	-39.0	-27.5
56	40.3	43.0	27	-50.9	-37.8
55	39.2	41.9	26	-64.6	-49.6
54	38.1	40.8	25		-63.1
53	37.0	39.7	24		-78.5
52	35.9	38.6			

TABLE 15. True Score Equating of FACT Ingenuity (Variable 54) to TALENT Creativity (Variable 32, R-260)

FACT-11 Ingenuity	R-260 - TALENT Creativity	
	Boys	Girls
24	20.3	17.6
23	19.2	16.4
22	18.0	15.3
21	16.7	14.5
20	15.5	13.7
19	14.2	12.9
18	13.0	12.2
17	11.9	11.4
16	10.8	10.7
15	9.8	9.9
14	8.9	9.2
13	8.0	8.4
12	7.2	7.7
11	6.5	7.0
10	5.8	6.4
9	5.2	5.8
8	4.6	5.3
7	4.1	4.8
6	3.6	4.4
5	3.1	3.9
4	2.6	3.5
3	2.2	
2	1.8	

TABLE 16. True Score Equating of FACT Scales (Variable 55) to TALENT Abstract Reasoning (Variable 36, R-290)

FACT-12 Scales	R-290 - TALENT Abstract Reasoning	
	Boys	Girls
49	14.6	
48	14.5	
47	14.5	
46	14.4	
45	14.3	
44	14.1	
43	14.0	14.6
42	13.8	14.5
41	13.7	14.4
40	13.5	14.2
39	13.3	14.1
38	13.1	13.9
37	12.9	13.7
36	12.6	13.5
35	12.4	13.3
34	12.1	13.1
33	11.9	12.8
32	11.6	12.6
31	11.3	12.3
30	11.0	12.0
29	10.7	11.7
28	10.3	11.4
27	10.0	11.0
26	9.6	10.7
25	9.2	10.3
24	8.8	9.9
23	8.4	9.5
22	8.0	9.1
21	7.6	8.7
20	7.1	8.2
19	6.6	7.8
18	6.2	7.3
17	5.6	6.8
16	5.1	6.3
15	4.6	5.7
14	4.0	5.2
13	3.4	4.6
12	2.8	4.1
11	2.2	3.5
10		2.9
9		2.2
8		1.6

TABLE 17. True Score Equating of FACT Expression (Variable 56) to TALENT Usage + Effective Expression (Variable 28 + 29, R-236)

FACT-13 Expression	R-236 - TALENT Usage + Effective Expression	
	Boys	Girls
62		36.3
61		35.3
60		34.5
59	34.5	33.7
58	34.0	33.0
57	33.5	32.4
56	32.9	31.8
55	32.4	31.2
54	31.9	30.8
53	31.4	30.3
52	30.9	29.8
51	30.5	29.4
50	30.0	29.0
49	29.5	28.6
48	29.0	28.2
47	28.5	27.8
46	28.0	27.4
45	27.5	27.0
44	27.0	26.6
43	26.5	26.1
42	26.0	25.7
41	25.4	25.2
40	24.9	24.8
39	24.3	24.3
38	23.7	23.8
37	23.2	23.3
36	22.6	22.8
35	21.9	22.3
34	21.3	21.7
33	20.6	21.2
32	20.0	20.7
31	19.3	20.1
30	18.5	19.6
29	17.8	19.1
28	17.0	18.6
27	16.2	18.2
26	15.4	17.8
25	14.5	17.4
24	13.6	
23	12.7	

TABLE 18. True Score Equating of FACT Alertness (Variable 57) to TALENT Object Inspection (Variable 43, F-440)

FACT-15 Alertness	F-440 - TALENT Object Inspection	
	Boys	Girls
34	37.7	
33	34.7	
32	31.9	36.2
31	29.3	35.5
30	26.8	34.0
29	24.6	32.0
28	22.7	29.7
27	21.0	27.4
26	19.7	25.3
25	18.5	23.4
24	17.6	21.8
23	16.8	20.5
22	16.1	19.6
21	15.4	18.8
20	14.6	18.0
19	13.7	17.2
18	12.4	15.9
17	10.7	13.9
16	8.4	10.9
15	5.4	6.4

TABLE 19. True Score Equating of FACT Patterns (Variable 58) to TALENT Visualization in 3 Dimensions (Variable 35, R-282)

FACT-17 Patterns	R-282 - TALENT Visualization in 3 Dimensions	
	Boys	Girls
44	16.3	
43	15.9	
42	15.5	
41	15.2	14.2
40	14.9	14.0
39	14.7	13.8
38	14.5	13.6
37	14.4	13.4
36	14.2	13.3
35	14.1	13.1
34	14.0	13.0
33	13.8	12.8
32	13.6	12.7
31	13.5	12.5
30	13.3	12.4
29	13.1	12.2
28	12.9	12.0
27	12.7	11.9
26	12.4	11.7
25	12.2	11.5
24	11.9	11.3
23	11.7	11.1
22	11.4	10.9
21	11.1	10.7
20	10.9	10.5
19	10.6	10.3
18	10.3	10.1
17	10.1	9.8
16	9.8	9.6
15	9.6	9.3
14	9.3	9.1
13	9.1	8.8
12	8.8	8.6
11	8.5	8.3
10	8.2	8.0
9	7.9	7.6
8	7.6	7.3
7	7.2	6.9
6	6.7	6.5
5	6.2	6.0
4	5.6	5.5
3	4.8	4.9
2	4.0	4.2
1	3.0	3.5
0		2.7

TABLE 20. True Score Equating of FACT Memory (Variable 60) to TALENT Memory for Words (Variable 23, R-212)

FACT-19 Memory	R-212 - TALENT Memory for Words	
	Boys	Girls
30	26.4	24.9
29	24.3	24.1
28	22.4	23.2
27	20.5	22.2
26	18.8	21.1
25	17.3	19.9
24	15.9	18.7
23	14.6	17.6
22	13.6	16.4
21	12.6	15.2
20	11.8	14.1
19	11.1	13.1
18	10.5	12.1
17	9.9	11.1
16	9.3	10.2
15	8.8	9.4
14	8.2	8.6
13	7.6	7.9
12	6.9	7.2
11	6.2	6.5
10	5.4	5.8
9	4.5	5.1
8	3.4	4.3
7	2.4	3.4
6	1.2	2.3
5		1.1

TABLE 21. True Score Equating of DAT Verbal Reasoning (Variable 61) to TALENT Vocabulary (Variable 1, R-172)

DAT-1 Verbal Reasoning	R-172 - TALENT Vocabulary		DAT-1 Verbal Reasoning	R-172 - TALENT Vocabulary	
	Boys	Girls		Boys	Girls
51		29.5	26	20.0	19.3
50		29.2	25	19.5	18.8
49	29.9	28.9	24	19.0	18.4
48	29.6	28.5	23	18.4	17.9
47	29.3	28.1	22	17.9	17.3
46	28.9	27.6	21	17.4	16.8
45	28.6	27.2	20	16.9	16.2
44	28.2	26.7	19	16.3	15.6
43	27.8	26.2	18	15.8	14.9
42	27.5	25.7	17	15.3	14.2
41	27.0	25.3	16	14.7	13.5
40	26.6	24.8	15	14.2	12.8
39	26.2	24.4	14	13.6	12.1
38	25.8	23.9	13	13.1	11.3
37	25.3	23.5	12	12.6	10.6
36	24.9	23.1	11	12.1	9.9
35	24.4	22.7	10	11.5	9.2
34	24.0	22.3	9	11.0	8.5
33	23.5	22.0	8	10.5	8.0
32	23.0	21.6	7	10.0	7.5
31	22.5	21.2	6	9.4	7.1
30	22.0	20.9	5	8.9	6.8
29	21.5	20.5	4	8.4	
28	21.0	20.1	3	7.9	
27	20.5	19.7	2	7.4	

TABLE 22. True Score Equating of DAT Numerical Ability (Variable 62) to TALENT Arithmetic Computation (Variable 40, F-410)

DAT-2 Numerical Ability	F-410 - TALENT Arithmetic Computation	
	Boys	Girls
42	55.2	
41	53.3	65.4
40	51.6	60.3
39	49.8	56.7
38	48.2	54.0
37	46.5	51.9
36	44.9	50.3
35	43.4	48.9
34	41.9	47.6
33	40.5	46.5
32	39.1	45.4
31	37.8	44.4
30	36.6	43.4
29	35.5	42.5
28	34.4	41.7
27	33.3	40.9
26	32.4	40.1
25	31.5	39.4
24	30.7	38.6
23	30.0	37.8
22	29.3	37.0
21	28.6	36.1
20	27.9	35.2
19	27.3	34.1
18	26.6	33.0
17	25.9	31.9
16	25.1	30.7
15	24.2	29.5
14	23.2	28.4
13	21.9	27.3
12	20.4	26.4
11	18.6	25.5
10	16.3	24.8
9	13.7	24.1
8	10.5	23.4
7	6.7	22.4
6	2.3	20.8
5	-3.0	18.2
4	-9.2	14.0
3	-16.3	7.3
2	-24.7	-2.9
1	-34.3	-17.9
0	-45.3	-39.4
-1	-57.8	-69.6
-2		-111.0

TABLE 23. True Score Equating of DAT Abstract Reasoning (Variable 63) to TALENT Abstract Reasoning (Variable 36, R-290)

DAT-3 Abstract Reasoning	R-290 - TALENT Abstract Reasoning		DAT-3 Abstract Reasoning	R-290 - TALENT Abstract Reasoning	
	Boys	Girls		Boys	Girls
49	15.3		23	7.9	7.7
48	14.8	15.1	22	7.6	7.4
47	14.3	14.6	21	7.4	7.2
46	13.9	14.1	20	7.1	7.0
45	13.5	13.6	19	6.9	6.8
44	13.1	13.3	18	6.6	6.7
43	12.7	12.9	17	6.4	6.5
42	12.4	12.6	16	6.1	6.3
41	12.1	12.3	15	5.9	6.2
40	11.8	12.0	14	5.6	6.1
39	11.5	11.7	13	5.3	5.9
38	11.3	11.5	12	5.1	5.8
37	11.0	11.2	11	4.8	5.7
36	10.8	10.9	10	4.6	5.5
35	10.6	10.7	9	4.3	5.4
34	10.3	10.4	8	4.1	5.2
33	10.1	10.2	7	3.8	5.0
32	9.9	9.9	6	3.6	4.8
31	9.7	9.7	5	3.3	4.6
30	9.4	9.4	4	3.1	4.2
29	9.2	9.1	3	2.9	3.9
28	9.0	8.9	2	2.6	3.4
27	8.8	8.6	1	2.4	2.9
26	8.6	8.4	0	2.2	2.2
25	8.3	8.1	-1	2.0	1.5
24	8.1	7.9			

TABLE 24. True Score Equating of DAT Space Relations (Variable 64) to TALENT Visualization in 3 Dimensions (Variable 35, R-282)

DAT-4 Space Relations	R-282 - TALENT Visualization in 3 Dimensions	
	Boys	Girls
97	16.4	
96	16.2	
95	16.0	
94	15.9	14.3
93	15.7	14.2
92	15.5	14.1
91	15.4	13.9
90	15.2	13.8
89	15.1	13.7
88	14.9	13.6
87	14.7	13.4
86	14.6	13.3
85	14.4	13.2
84	14.3	13.1
83	14.1	12.9
82	14.0	12.8
81	13.8	12.7
80	13.6	12.6
79	13.5	12.5
78	13.3	12.3
77	13.2	12.2
76	13.0	12.1
75	12.9	12.0
74	12.7	11.8
73	12.6	11.7
72	12.4	11.6
71	12.3	11.5
70	12.1	11.4
69	12.0	11.2
68	11.8	11.1
67	11.7	11.0
66	11.5	10.9
65	11.4	10.8
64	11.2	10.6
63	11.1	10.5
62	11.0	10.4
61	10.8	10.3
60	10.7	10.2
59	10.5	10.1
58	10.4	9.9
57	10.3	9.8
56	10.1	9.7
55	10.0	9.6
54	9.9	9.5
53	9.7	9.4
52	9.6	9.2
51	9.5	9.1
50	9.3	9.0
49	9.2	8.9
48	9.1	8.8
47	9.0	8.7
46	8.8	8.5
45	8.7	8.4
44	8.6	8.3
43	8.5	8.2
42	8.4	8.1
41	8.3	8.0
40	8.1	7.9
39	8.0	7.7
38	7.9	7.6
37	7.8	7.5
36	7.7	7.4
35	7.6	7.3
34	7.5	7.2
33	7.4	7.1
32	7.3	7.0
31	7.2	6.8
30	7.1	6.7
29	7.0	6.6
28	6.9	6.5
27	6.8	6.4
26	6.7	6.3
25	6.6	6.2
24	6.5	6.1
23	6.4	6.0
22	6.3	5.8
21	6.2	5.7
20	6.1	5.6
19	6.0	5.5
18	5.9	5.4
17	5.8	5.3
16	5.7	5.2
15	5.6	5.1
14	5.5	5.0
13	5.4	4.9
12	5.3	4.8
11	5.1	4.6
10	5.0	4.5
9	4.9	4.4
8	4.8	4.3
7	4.7	4.2
6	4.6	4.1
5	4.5	4.0
4	4.3	3.9
3	4.2	3.8
2	4.1	3.7
1	3.9	3.6
0	3.8	3.5
-1	3.6	
-2	3.5	
-3	3.3	

TABLE 25. True Score Equating of DAT Mechanical Reasoning (Variable 65) to TALENT Mechanical Reasoning (Variable 33, R-270)

DAT-5 Mechanical Reasoning	R-270 - TALENT Mechanical Reasoning		DAT-5 Mechanical Reasoning	R-270 - TALENT Mechanical Reasoning	
	Boys	Girls		Boys	Girls
67	20.7		34	10.2	10.6
66	20.4		33	9.8	10.2
65	20.1		32	9.6	9.9
64	19.8		31	9.3	9.6
63	19.5		30	9.0	9.3
62	19.2		29	8.7	9.0
61	18.8		28	8.4	8.7
60	18.5		27	8.2	8.4
59	18.2		26	7.9	8.1
58	17.9		25	7.7	7.8
57	17.6		24	7.5	7.6
56	17.3		23	7.2	7.3
55	17.0		22	7.0	7.1
54	16.7		21	6.8	6.8
53	16.4		20	6.6	6.6
52	16.0		19	6.5	6.3
51	15.7		18	6.3	6.1
50	15.4		17	6.1	5.9
49	15.1	17.0	16	6.0	5.7
48	14.7	16.4	15	5.9	5.5
47	14.4	15.9	14	5.7	5.2
46	14.1	15.5	13	5.6	5.0
45	13.7	15.0	12	5.5	4.8
44	13.4	14.5	11	5.4	4.6
43	13.1	14.1	10	5.3	4.4
42	12.7	13.6	9	5.2	4.2
41	12.4	13.2	8	5.1	4.0
40	12.1	12.8	7	5.0	3.8
39	11.7	12.4	6	5.0	3.6
38	11.4	12.0	5	4.9	3.4
37	11.1	11.6	4	4.8	3.2
36	10.8	11.3	3		3.0
35	10.5	10.9			

TABLE 26. True Score Equating of DAT Clerical Speed & Accuracy (Variable 66) to TALENT Clerical Checking (Variable 42, F-430)

DAT-6 Clerical Speed & Accuracy	F-430 - TALENT Clerical Checking		DAT-6 Clerical Speed & Accuracy	F-430 - TALENT Clerical Checking	
	Boys	Girls		Boys	Girls
101	62.8		62	31.5	29.0
100	62.5		61	30.2	27.9
99	62.2		60	28.9	26.8
98	61.9		59	27.7	25.7
97	61.6	59.0	58	26.4	24.7
96	61.2	58.5	57	25.2	23.7
95	60.9	58.1	56	23.9	22.7
94	60.5	57.7	55	22.7	21.7
93	60.1	57.3	54	21.4	20.7
92	59.7	56.9	53	20.2	19.7
91	59.2	56.5	52	19.0	18.8
90	58.7	56.0	51	17.8	17.8
89	58.1	55.6	50	16.6	16.8
88	57.6	55.1	49	15.4	15.8
87	57.0	54.5	48	14.2	14.7
86	56.3	53.9	47	13.0	13.6
85	55.6	53.3	46	11.9	12.4
84	54.9	52.6	45	10.8	11.1
83	54.2	51.9	44	9.6	9.7
82	53.4	51.1	43	8.5	8.1
81	52.5	50.3	42	7.4	6.4
80	51.7	49.4	41	6.3	4.5
79	50.8	48.4	40	5.2	2.5
78	49.8	47.5	39	4.1	0.1
77	48.8	46.4	38	3.0	-2.5
76	47.8	45.4	37	1.9	-5.4
75	46.8	44.3	36	0.8	-8.7
74	45.7	43.2	35	-0.3	-12.4
73	44.7	42.0	34	-1.4	-16.5
72	43.5	40.8	33	-2.6	
71	42.4	39.6	32	-3.7	
70	41.3	38.4	31	-4.9	
69	40.1	37.2	30	-6.1	
68	38.9	36.0	29	-7.4	
67	37.7	34.8	28	-8.7	
66	36.4	33.6	27	-10.0	
65	35.2	32.4	26	-11.5	
64	34.0	31.3	25	-12.9	
63	32.7	30.1			

TABLE 27. True Score Equating of DAT Spelling (Variable 67) to TALENT Spelling (Variable 25, R-231)

DAT-7I Spelling	R-231 - TALENT Spelling		DAT-7I Spelling	R-231 - TALENT Spelling	
	Boys	Girls		Boys	Girls
106	15.4		50	9.1	9.4
105	15.2		49	9.0	9.3
104	15.1		48	8.9	9.3
103	14.9	15.7	47	8.8	9.2
102	14.7	15.5	46	8.8	9.2
101	14.5	15.3	45	8.7	9.2
100	14.4	15.2	44	8.6	9.1
99	14.2	15.0	43	8.5	9.1
98	14.0	14.8	42	8.5	9.0
97	13.9	14.7	41	8.4	9.0
96	13.8	14.5	40	8.3	8.9
95	13.6	14.3	39	8.3	8.9
94	13.5	14.1	38	8.2	8.8
93	13.3	14.0	37	8.1	8.8
92	13.2	13.8	36	8.0	8.7
91	13.1	13.7	35	8.0	8.7
90	12.9	13.5	34	7.9	8.6
89	12.8	13.3	33	7.8	8.6
88	12.7	13.2	32	7.8	8.5
87	12.6	13.0	31	7.7	8.4
86	12.5	12.9	30	7.6	8.4
85	12.4	12.7	29	7.5	8.3
84	12.2	12.6	28	7.5	8.2
83	12.1	12.4	27	7.4	8.1
82	12.0	12.3	26	7.3	8.0
81	11.9	12.2	25	7.3	8.0
80	11.8	12.0	24	7.2	7.9
79	11.7	11.9	23	7.1	7.7
78	11.6	11.8	22	7.0	7.6
77	11.5	11.6	21	6.9	7.5
76	11.4	11.5	20	6.9	7.4
75	11.3	11.4	19	6.8	7.3
74	11.2	11.3	18	6.7	7.1
73	11.1	11.2	17	6.6	7.0
72	11.0	11.1	16	6.5	6.8
71	10.9	10.9	15	6.4	6.6
70	10.8	10.8	14	6.3	6.5
69	10.7	10.7	13	6.2	6.3
68	10.6	10.6	12	6.1	6.1
67	10.5	10.6	11	5.9	5.8
66	10.4	10.5	10	5.8	5.6
65	10.4	10.4	9	5.7	5.4
64	10.3	10.3	8	5.5	5.1
63	10.2	10.2	7	5.4	4.8
62	10.1	10.1	6	5.2	4.6
61	10.0	10.1	5	5.1	4.3
60	9.9	10.0	4	4.9	3.9
59	9.8	9.9	3	4.7	3.6
58	9.7	9.8	2	4.5	
57	9.6	9.8	1	4.3	
56	9.6	9.7	0	4.1	
55	9.5	9.7	-1	3.9	
54	9.4	9.6	-2	3.7	
53	9.3	9.5	-3	3.4	
52	9.2	9.5	-4	3.2	
51	9.2	9.4			

TABLE 28. True Score Equating of DAT Sentences (Variable 68) to TALENT English Total (Variables 25-29, R-230)

DAT-7II Sentences	R-230 - TALENT English Total		DAT-7II Sentences	R-230 - TALENT English Total	
	Boys	Girls		Boys	Girls
82		110.7	39	85.4	86.2
81		110.0	38	84.7	85.7
80		109.3	37	84.0	85.3
79		108.6	36	83.2	84.8
78		108.0	35	82.5	84.3
77	108.6	107.4	34	81.8	83.9
76	107.5	106.9	33	81.1	83.4
75	106.5	106.3	32	80.4	83.0
74	105.6	105.8	31	79.7	82.5
73	104.8	105.2	30	79.0	82.1
72	104.0	104.7	29	78.3	81.6
71	103.3	104.2	28	77.6	81.2
70	102.7	103.7	27	76.9	80.7
69	102.1	103.1	26	76.2	80.2
68	101.6	102.6	25	75.6	79.7
67	101.1	102.1	24	74.9	79.2
66	100.6	101.5	23	74.3	78.7
65	100.1	101.0	22	73.7	78.1
64	99.6	100.4	21	73.0	77.5
63	99.2	99.9	20	72.4	76.8
62	98.7	99.3	19	71.8	76.1
61	98.3	98.7	18	71.1	75.3
60	97.8	98.2	17	70.5	74.4
59	97.4	97.6	16	69.9	73.5
58	96.9	97.0	15	69.2	72.5
57	96.5	96.4	14	68.6	71.3
56	96.0	95.8	13	67.9	70.1
55	95.5	95.2	12	67.2	68.8
54	95.0	94.6	11	66.5	67.3
53	94.4	94.0	10	65.7	65.6
52	93.9	93.4	9	64.9	63.8
51	93.3	92.8	8	64.0	61.9
50	92.7	92.3	7	63.1	59.7
49	92.1	91.7	6	62.1	57.3
48	91.5	91.1	5	61.1	54.8
47	90.9	90.5	4	60.0	51.9
46	90.2	89.9	3	58.7	48.9
45	89.6	89.4	2	57.4	45.5
44	88.9	88.8	1	55.9	
43	88.2	88.3	0	54.3	
42	87.5	87.8	-1	52.6	
41	86.8	87.2	-2	50.7	
40	86.1	86.7	-3	48.6	

TABLE 29. True Score Equating of GATB Name Comparison (Variable 69) to TALENT Clerical Checking (Variable 42, F-430)

GATB-1 Name Comparison	F-430 - TALENT Clerical Checking		GATB-1 Name Comparison	F-430 - TALENT Clerical Checking	
	Boys	Girls		Boys	Girls
92		60.2	60	36.3	30.2
91		59.7	59	34.4	29.0
90		59.1	58	32.6	27.9
89		58.5	57	30.8	26.7
88		57.8	56	29.1	25.5
87		57.1	55	27.4	24.3
86		56.4	54	25.8	23.1
85		55.6	53	24.3	21.9
84		54.8	52	22.8	20.7
83		54.0	51	21.3	19.4
82		53.2	50	19.9	18.2
81		52.3	49	18.6	16.9
80		51.4	48	17.2	15.7
79		50.4	47	15.9	14.4
78		49.5	46	14.5	13.1
77	64.3	48.5	45	13.2	11.7
76	63.7	47.5	44	11.8	10.4
75	62.9	46.5	43	10.3	9.0
74	61.8	45.5	42	8.8	7.7
73	60.5	44.5	41	7.1	6.2
72	59.1	43.5	40	5.4	4.8
71	57.5	42.4	39	3.5	3.3
70	55.8	41.3	38	1.4	1.8
69	54.0	40.3	37	-0.9	0.3
68	52.1	39.2	36	-3.4	-1.3
67	50.2	38.1	35	-6.1	-2.9
66	48.2	37.0	34	-9.2	-4.5
65	46.2	35.9	33	-12.5	-6.2
64	44.1	34.7	32	-16.3	-7.9
63	42.1	33.6	31		-9.7
62	40.1	32.5	30		-11.5
61	38.2	31.3	29		-13.4

TABLE 30. True Score Equating of GATB Computation (Variable 70) to TALENT Arithmetic Computation (Variable 40, F-410)

GATB-2 Computation	F-410 - TALENT Arithmetic Computation	
	Boys	Girls
40		62.2
39		59.0
38	55.5	56.6
37	54.1	54.5
36	52.4	52.7
35	50.6	51.0
34	48.7	49.4
33	46.8	47.7
32	44.8	45.9
31	42.8	43.9
30	40.7	41.9
29	38.6	39.8
28	36.4	37.6
27	34.1	35.3
26	31.6	33.0
25	28.7	30.6
24	25.5	28.2
23	21.8	25.7
22	17.4	23.1
21	12.3	20.2
20	6.2	17.1
19	-0.9	13.5
18	-9.4	9.2
17	-19.3	3.9
16	-31.0	-2.6
15	-44.6	-10.6
14	-60.5	-20.8
13		-33.4
12		-49.2
11		-68.8
10		-93.0

TABLE 31. True Score Equating of GATB Three-Dimensional Space (Variable 71) to TALENT Visualization in 3 Dimensions (Variable 35, R-282)

GATB-3 Three-Dimensional Space	R-282 - TALENT Visualization in 3 Dimensions	
	Boys	Girls
34	16.6	
33	16.3	
32	16.1	
31	15.9	14.3
30	15.6	14.1
29	15.3	13.9
28	14.9	13.7
27	14.5	13.5
26	14.0	13.2
25	13.4	12.9
24	12.8	12.4
23	12.1	11.9
22	11.4	11.3
21	10.7	10.6
20	10.0	9.9
19	9.2	9.2
18	8.5	8.4
17	7.7	7.7
16	7.0	7.1
15	6.4	6.5
14	5.8	5.9
13	5.2	5.5
12	4.7	5.0
11	4.2	4.7
10	3.8	4.3
9	3.4	3.8
8		3.3

TABLE 32. True Score Equating of GATB Vocabulary (Variable 72) to TALENT Vocabulary (Variable 1, R-172)

GATB-4 Vocabulary	R-172 - TALENT Vocabulary	
	Boys	Girls
47		29.3
46		29.3
45		29.3
44		29.2
43		29.0
42		28.8
41		28.6
40	29.9	28.3
39	29.5	28.0
38	29.1	27.6
37	28.8	27.3
36	28.4	26.9
35	28.1	26.5
34	27.8	26.0
33	27.4	25.6
32	27.1	25.1
31	26.6	24.6
30	26.2	24.0
29	25.7	23.5
28	25.1	22.9
27	24.5	22.3
26	23.9	21.6
25	23.2	20.9
24	22.5	20.2
23	21.8	19.5
22	21.0	18.7
21	20.2	17.9
20	19.4	17.1
19	18.5	16.3
18	17.7	15.4
17	16.8	14.6
16	16.0	13.7
15	15.2	12.8
14	14.3	12.0
13	13.5	11.2
12	12.6	10.4
11	11.8	9.6
10	11.0	9.0
9	10.2	8.4
8	9.3	7.9
7	8.5	7.5
6	7.6	7.3
5		7.3
4		7.2
3		7.2

TABLE 33. True Score Equating of GATB Tool Matching (Variable 73) to TALENT Object Inspection (Variable 43, F-440)

GATB-5 Tool Matching	F-440 - TALENT Object Inspection	
	Boys	Girls
46	34.8	37.3
45	33.7	35.5
44	33.0	33.6
43	32.3	31.8
42	31.5	30.2
41	30.6	28.6
40	29.6	27.1
39	28.4	25.8
38	27.0	24.6
37	25.6	23.5
36	24.2	22.5
35	22.8	21.5
34	21.5	20.6
33	20.3	19.7
32	19.3	18.8
31	18.5	17.8
30	17.6	16.8
29	16.7	15.7
28	15.6	14.5
27	13.9	13.3
26	11.3	12.0
25	7.5	10.6
24	1.8	9.2
23		7.8
22		6.5
21		5.2

TABLE 34. True Score Equating of GATB Arithmetic Reasoning (Variable 74) to TALENT Arithmetic Reasoning (Variable 37, R-311)

GATB-6 Arithmetic Reasoning	R-311 - TALENT Arithmetic Reasoning	
	Boys	Girls
21		16.0
20	15.8	15.5
19	15.4	14.9
18	14.8	14.2
17	13.9	13.5
16	12.9	12.6
15	11.7	11.7
14	10.5	10.6
13	9.3	9.6
12	8.1	8.5
11	7.0	7.4
10	6.0	6.4
9	5.1	5.4
8	4.2	4.5
7	3.2	3.8
6	1.9	3.1
5	0.3	2.7
4		2.6

TABLE 35. True Score Equating of GATB Form Matching (Variable 75) to TALENT Object Inspection (Variable 43, F-440)

GATB-7 Form Matching	F-440 - TALENT Object Inspection	
	Boys	Girls
47	34.1	
46	33.9	36.2
45	33.8	35.5
44	33.8	35.0
43	33.7	34.7
42	33.5	34.3
41	33.2	33.9
40	32.7	33.3
39	32.2	32.5
38	31.4	31.5
37	30.6	30.4
36	29.6	29.2
35	28.5	27.9
34	27.3	26.6
33	26.0	25.3
32	24.6	24.1
31	23.3	23.0
30	21.9	22.0
29	20.5	21.2
28	19.2	20.4
27	17.9	19.6
26	16.7	18.8
25	15.5	17.7
24	14.4	16.2
23	13.3	14.0
22	12.2	10.9
21	11.0	6.4
20	9.8	
19	8.5	
18	6.9	
17	5.0	

TABLE 36.* Raw Scores Corresponding to Selected Percentiles for TALENT R-236 (English Usage + Effective Expression)

37 items

%ile	Raw Score											
	Boys				Girls				Total			
	Gr. 9	Gr. 10	Gr. 11	Gr. 12	Gr. 9	Gr. 10	Gr. 11	Gr. 12	Gr. 9	Gr. 10	Gr. 11	Gr. 12
99	32.4	33.4	34.3	34.7	32.9	34.1	34.6	35.3	32.7	33.9	34.5	35.1
98	31.5	32.6	33.4	34.0	32.2	33.3	34.1	34.7	31.9	33.1	33.8	34.4
95	30.0	31.2	32.1	32.8	31.0	32.0	32.9	33.6	30.6	31.6	32.6	33.3
90	28.5	29.9	30.9	31.7	29.7	30.8	31.7	32.6	29.2	30.3	31.3	32.2
85	27.4	28.9	29.9	30.9	28.9	29.9	30.8	31.9	28.3	29.4	30.4	31.4
80	26.5	28.0	29.1	30.1	28.1	29.1	30.1	31.2	27.5	28.6	29.7	30.7
75	25.7	27.2	28.4	29.5	27.5	28.4	29.5	30.6	26.7	27.9	29.0	30.1
70	25.0	26.5	27.8	28.8	26.8	27.8	29.0	30.0	26.0	27.2	28.4	29.5
60	23.7	25.2	26.6	27.6	25.6	26.7	27.9	29.0	24.7	26.0	27.3	28.3
50	22.4	23.9	25.4	26.5	24.5	25.6	26.8	28.0	23.5	24.8	26.1	27.3
40	21.0	22.7	24.1	25.3	23.3	24.4	25.6	26.9	22.2	23.5	24.9	26.1
30	19.3	21.2	22.6	23.9	21.9	23.1	24.3	25.7	20.7	22.1	23.5	24.8
25	18.4	20.3	21.9	23.1	21.1	22.4	23.6	25.0	19.7	21.3	22.7	24.0
20	17.3	19.2	20.9	22.2	20.2	21.5	22.7	24.1	18.8	20.2	21.8	23.1
15	16.1	17.9	19.8	21.0	19.1	20.2	21.6	23.0	17.6	19.0	20.7	22.0
10	14.5	16.3	18.3	19.5	17.8	18.9	20.3	21.8	16.0	17.5	19.2	20.6
5	12.1	13.7	15.9	17.2	15.7	16.8	18.2	19.6	13.6	15.0	17.0	18.2
2	8.9	10.1	12.7	13.7	12.7	13.9	15.6	16.1	10.4	11.5	14.0	14.9
1	6.9	7.6	9.5	10.1	10.7	11.0	13.3	13.2	8.1	8.6	11.2	11.6
N	4876	4978	4430	3863	5059	4789	4658	4119	9935	9767	9088	7982
Weighted N in 100's	10603	10609	9389	8309	10883	10190	9937	8660	21486	20799	19326	16969

* The data in this table are based on TALENT subsample A-10.0-3, a representative 10 percent of the entire TALENT probability sample, as described in The American High School Student (Flanagan et al., 1964, Chapter 2). The cases have been weighted to represent the national population of high school students; weight A (Flanagan et al., 1964, Chapter 2) was used for the purpose. This table presents data parallel to that in Table 3-2 of The American High School Student.

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APPENDIX I. SMOOTHING

In order to smooth a frequency value f_0, we fit a parabola or a cubic to f_0 and the two or three frequencies immediately preceding and following it. The equation of the cubic is:

$$\hat{f}_0 = a + bx + cx^2 + dx^3, \tag{1}$$

and the function to be minimized is

$$Q = \Sigma\,(f_0 - a - bx - cx^2 - dx^3)^2. \tag{2}$$

For the parabola, we omit dx^3 in (1) and (2). Then differentiating Q with respect to a, b, c, and d, and setting the derivatives equal to zero,

$$\Sigma[2(f_0 - a - bx - cx^2 - dx^3)(-1)] = 0,$$

$$\Sigma[2(f_0 - a - bx - cx^2 - dx^3)(-x)] = 0,$$

$$\Sigma[2(f_0 - a - bx - cx^2 - dx^3)(-x^2)] = 0,$$

$$\Sigma[2(f_0 - a - bx - cx^2 - dx^3)(-x^3)] = 0.$$

Ignoring the minus signs in the last factors, and the constants 2 (since $-2 \neq 0$), we obtain the normal equations,

$$an + b\Sigma x + c\Sigma x^2 + d\Sigma x^3 = \Sigma f, \tag{3}$$

$$a\Sigma x + b\Sigma x^2 + c\Sigma x^3 + d\Sigma x^4 = \Sigma fx, \tag{4}$$

$$a\Sigma x^2 + b\Sigma x^3 + c\Sigma x^4 + d\Sigma x^5 = \Sigma fx^2, \tag{5}$$

$$a\Sigma x^3 + b\Sigma x^4 + c\Sigma x^5 + d\Sigma x^6 = \Sigma fx^3. \tag{6}$$

In fitting a parabola, each term with coefficient d is omitted, along with all of equation (6).

The summations are over 5 or 7 frequency groups, so that n = 5 or 7, and Σf does <u>not</u> equal n. The relevant data are now:

5-point fit

f	x	x^2	x^3	x^4
f_2	2	4	8	16
f_1	1	1	1	1
f_0	0	0	0	0
f_{-1}	-1	1	-1	1
f_{-2}	-2	4	-8	16
Σf	0=	10=	0=	34=
(n=5)	Σx	Σx^2	Σx^3	Σx^4

7-point fit

f	x	x^2	x^3	x^4
f_3	3	9	27	81
f_2	2	4	8	16
f_1	1	1	1	1
f_0	0	0	0	0
f_{-1}	-1	1	-1	1
f_{-2}	-2	4	-8	16
f_{-3}	-3	9	-27	81
Σf	0=	28=	0=	196=
(n=7)	Σx	Σx^2	Σx^3	Σx^4

It is evident that for both of these tables, Σx^5 will equal 0. We require only $\hat{f}_0$, the value of f_0 at $x = 0$, and from (1) it is clear that at $x = 0$, $f_0 = a$. In (4) and (5), the coefficient of a is 0 (Σx and Σx^3), so we need only (3) and (5) to find a, and these equations reduce to

$$an + c\Sigma x^2 = \Sigma f, \tag{7}$$

$$a\Sigma x^2 + c\Sigma x^4 = \Sigma f x^2. \tag{8}$$

In these equations there are no d-terms, and equation (6) is not used. Hence the value of a is the same whether we fit a parabola or a cubic.

Inserting the explicit values of n, Σx^2, and Σx^4 from the two tables, equations (7) and (8) become,

$$5a + 10c = \Sigma f, \qquad 7a + 28c = \Sigma f,$$

$$10a + 34c = \Sigma f x^2. \qquad 28a + 196c = \Sigma f x^2.$$

To eliminate c, multiply the first equation on the left by 3.4 and subtract from the second; multiply the first equation on the right by 7 and subtract from the second. Then

$$7a = 3.4\Sigma f - \Sigma f x^2, \qquad 2/a = 7\Sigma f - \Sigma f x^2$$

$$35a = 17\Sigma f - 5\Sigma f x^2, \qquad a = (7\Sigma f - \Sigma f x^2)/21.$$

$$a = (17\Sigma f - 5\Sigma f x^2)/35.$$

Putting into the last of each of these equations the explicit values of x, and writing $\hat{f}_0$ for a, we have,

$$\begin{aligned}\hat{f}_0 &= (17f_2 + 17f_1 + 17f_0 + 17f_{-1} + 17f_{-2} \\ &\quad -20f_0 - 5f_1 \qquad\qquad -5f_{-1} - 20f_{-2})/35 \\ &= (-3f_0 + 12f_1 + 17f_0 + 12f_{-1} - 3f_{-2})/35;\end{aligned} \tag{9}$$

$$\hat{f}_0 = (7f_3 + 7f_2 + 7f_1 + 7f_0 + 7f_{-1} + 7f_{-2} + 7f_{-3}$$
$$- 9f_3 - 4f_2 - f_1 - f_{-1} - 4f_{-2} - 9f_{-3})/21$$
$$= (-2f_3 + 3f_2 + 6f_1 + 7f_0 + 6f_{-1} + 3f_{-2} - 2f_{-3})/21. \quad (10)$$

More compact derivations of these formulas are given in The Advanced Theory of Statistics (Kendall, 1948) in the context of the smoothing of time series, with extensions to weighted moving averages which preserve quartic and quintic trends.